Eastern Oregon Fire Regime Mapping

Documentation

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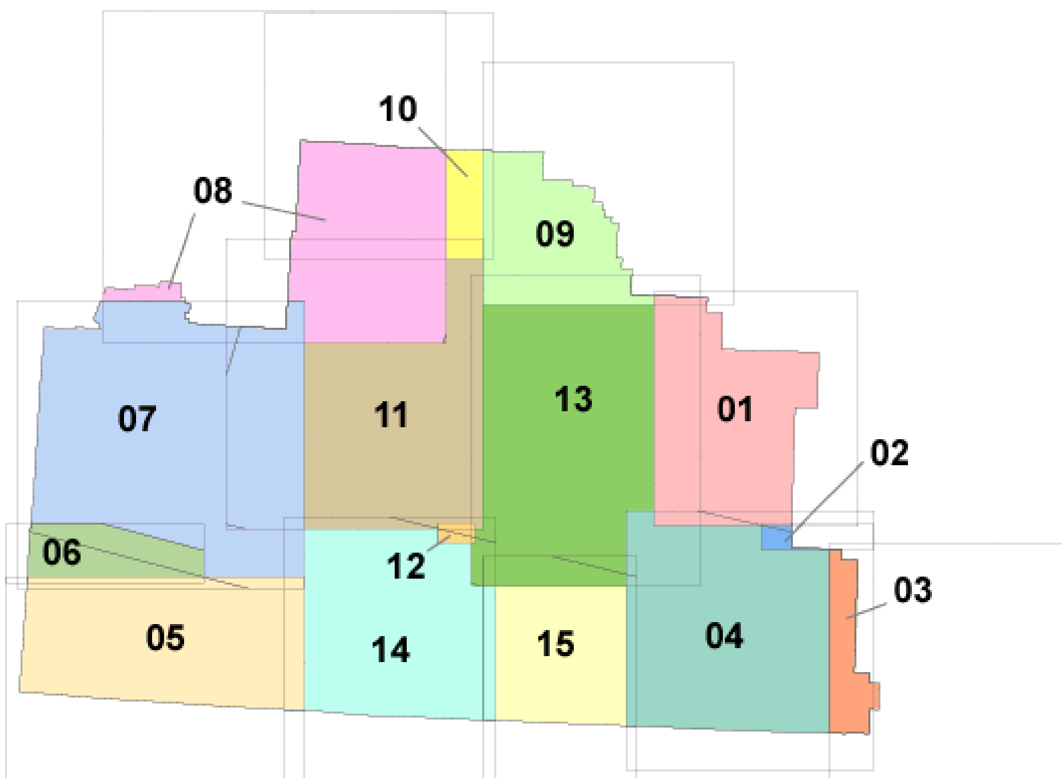
Introduction
The objectives were as follows:

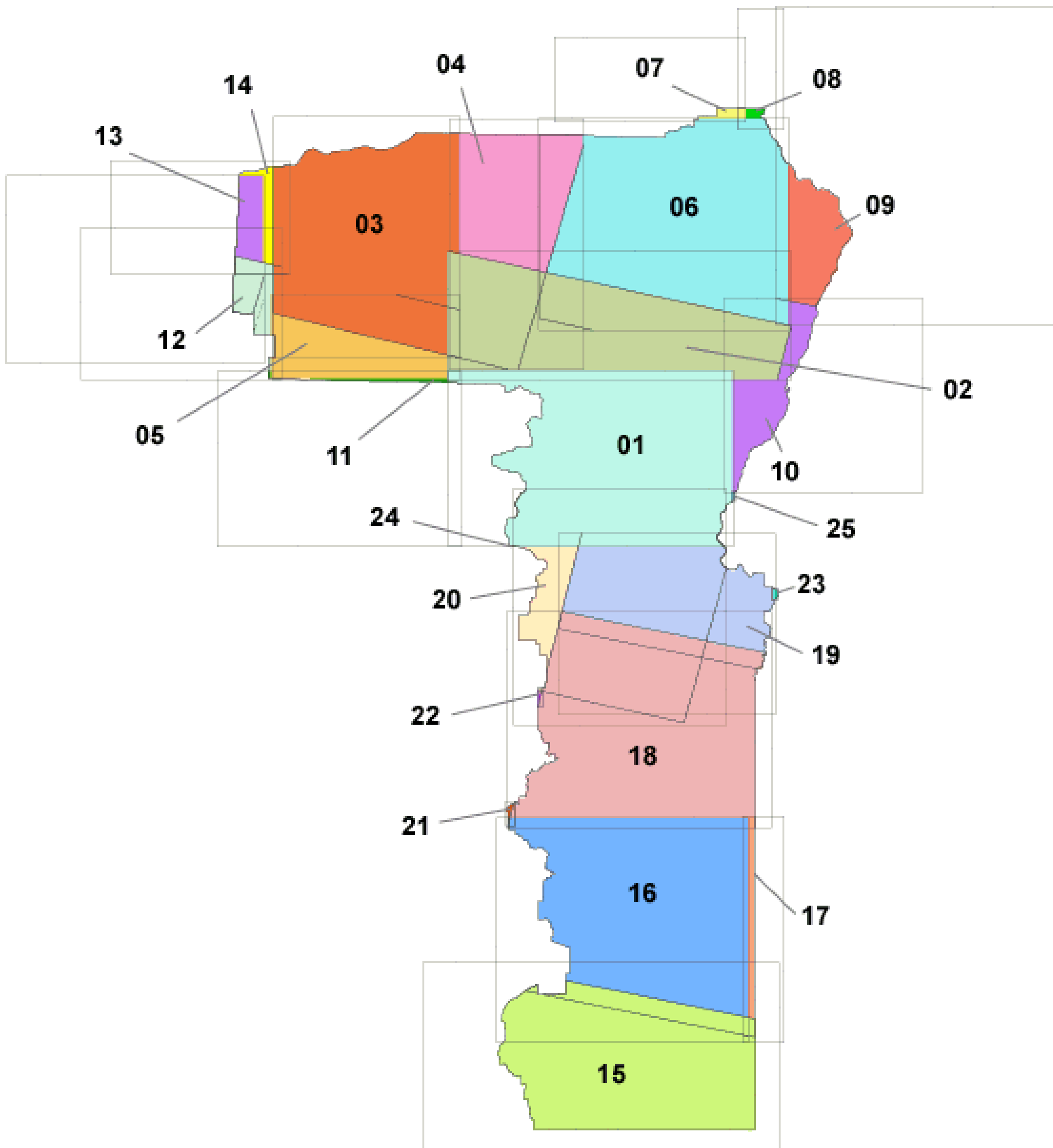
1. To create a map of fire regimes for Lakeview BLM and Vale BLM using existing vegetation data provided by Bob Rietman. This will be referred to as the original vegetation data.
2. To mosaic Lakeview and Vale to existing fire regime maps for Burns and Prineville
3. To overlay any Forest Service Fire regime data
4. To produce area statistics for fire regimes by land ownership
5. Deliver data and documentation on CD to Louisa Evers and to post online.

Data
A total of thirty-five vegetation maps created by unsupervised classification of 1999 and 2000 Landsat imagery were provided by Bob Rietman (Appendix I). The combined extent of the vegetation maps covered the majority of the Vale and entire Lakeview BLM districts (Maps 1 and 2). Due to spectral and land cover variability between each of the Landsat images used to create the original vegetation maps, each vegetation map had a unique classification scheme (i.e. different numbers represent different types of cover types).

Map 1. Extent and placement of vegetation maps for the BLM Lakeview District



Map 2. Extent and placement of vegetation maps for the BLM Vale District



Methods

1. Create a common legend

The first step toward creating fire regime maps for Vale and Lakeview was to combine and re-order each classification scheme to a common, comprehensive legend (Tables 1 and 2). Once applied to each map, adjacent maps could be combined without conflict.

Table 1. Revisions made to the original 35 Bob Rietman classifications

1	ag/riparian = agriculture
2	mixed brush, mixed shrub, brush, etc. = shrub
3	fire forbs = forbs
4	dry ag = agriculture
5	riparian/shrub = shrub
6	water/shadow = water
7	mc1/brush = mixed conifer, shrub
8	sage1/grass = sagebrush, grass
9	brush/forbs = shrub, forbs
10	pp/df/ag = ponderosa pine, Douglas fir
11	mc2/ag = mixed conifer medium
12	ag/barren = agriculture
13	rock/water = water
14	dry grass = grass
15	rock/ARTR-lo = sagebrush low
16	Class 3 = sagebrush, grass
17	pumice = barren
18	sand = barren
19	alpine/grass/forbs = snow
20	alpine = barren
21	bunchgrass, talus = grass
22	plantation = mixed conifer medium
23	sagebrush, grass, barren = sagebrush, grass
24	greasewood, barren = greasewood low
25	juniper, barren = juniper low
26	sagebrush, barren = sagebrush low
27	sagebrush, greasewood, barren = sagebrush, greasewood
28	spiny? = spiny hopsage
29	rock, etc. = barren (or dropped)

Table 2. Final, common legend applied to each of the original vegetation maps

1	water	26	mixed conifer, shrub
2	urban	27	mountain mahogany
3	agriculture	28	ponderosa pine low
4	barren	29	ponderosa pine medium
5	snow	30	ponderosa pine high
6	Other (cloud, shadow, noise)	31	ponderosa pine, bitterbrush
7	riparian	32	ponderosa pine, Douglas fir
8	lava	33	ponderosa pine, grass
9	null	34	ponderosa pine, lodgepole pine
10	deciduous forest	35	rabbitbrush
11	forbs	36	rabbitbrush, grass
12	grass	37	rabbitbrush, bitterbrush, sagebrush
13	greasewood low	38	rabbitbrush, bitterbrush, grass
14	greasewood medium	39	sagebrush low
15	greasewood, sagebrush	40	sagebrush medium
16	juniper low	41	sagebrush high
17	juniper medium	42	sagebrush, grass
18	juniper, grass	43	sagebrush, greasewood
19	juniper, sagebrush	44	shrub
20	lodgepole pine medium	45	shrub, forb
21	lodgepole pine high	46	shrub, grass
22	lodgepole pine, bitterbrush	47	spiny hopsage
23	lodgepole pine, Englemann spruce	48	subalpine fir high
24	mixed conifer medium	255	background
25	mixed conifer high		

The final, recoded maps contained a total of 49 classes, including the background (class 255). The classes are not mutually exclusive. While revising the classification, all plant species names were spelled out (Table 3). In addition, numbers 01, 02, and 03 were replaced with low, medium, and high, respectively. The low, medium, and high characterizations reflect vegetation density, but have no quantative definition. If a number was used in combination with another vegetation type, the number was dropped. If a vegetation type was used in combination with a mask class, the mask class was dropped. During the revision, much of the riparian mask class was dissolved into the agriculture class. Likewise, much of the topography shadow class was lost to the water class.

Table 3. Plant species and their original codes:

1	pp = ponderosa pine
2	df = Douglas fir
3	sub = subalpine fir
4	lp = lodgepole pine
5	grease = greasewood
6	es = Englemann spruce
7	rb = rabbitbrush
8	bb = bitterbrush
9	sage = sagebrush
10	spiny? = spiny hopsage
11	mtn. mah = mountain mahogany
12	jun = juniper

2. Data Prep.
Registration between vegetation maps was checked and corrected where necessary.
The original vegetation maps were clipped to the Vale and Lakeview District boundaries.
Raw Landsat imagery from 1999 data was then subset to the clipped maps for use during the mask editing process.

3. Missing Data
Five small areas within the Vale district boundary were missed during the original vegetation mapping. The original unsupervised classification was replicated on each new area.

4. Mask Edits
The original vegetation maps identified the majority of the natural land cover, but failed to accurately map water, urban, agriculture, etc (land use/cover referred to as mask classes). In order to improve the accuracy and utility of the fire regime maps, effort was put toward improving their identification. Landsat images were first subset using Lakeview and Vale BLM district boundary coverages. Each raw Landsat scene was then classified, using supervised and unsupervised techniques, into one of ten classes: water, urban, agriculture, barren, snow, other (cloud, cloud shadow, topographic shadow and noise), riparian, lava, wetlands, and vegetation. The output classification is called a mask.

These new mask classes were overlaid onto the recoded vegetation maps. The mask classes were maintained when both the new mask and the recoded vegetation map both identified a mask class. Areas where both maps had a vegetation call were given the recoded vegetation map value. Areas where the new mask was classified as vegetation and the recoded vegetation map was classified as a mask class, temporary classes were output to denote the discrepancy. These temporary classes were recoded to the original vegetation map and then recoded to the class, vegetation or mask, which they most resembled in the recoded vegetation map classification scheme.

5. The mosaicking of the edited vegetation maps
The 15 subsets for Lakeview and the 25 subsets for Vale were stitched together. In the subset overlap, rules were set to minimize any stitch lines between the subsets. Although the resulting two maps were not entirely seamless, they were consistent and provided complete coverage.

6. Recoded vegetation cover to fire regimes

Appendix II provides the definitions of the fire regimes used for this project. Vale and Lakeview were provided with the vegetation land cover legend, and were asked to label each land cover type with the most applicable fire regime according to the definitions in Appendix II. The vegetation land cover maps were recoded or reclassed to these fire regimes (see appendix III). The fire regimes can be species dependent. For a couple of the shrub classes no species were identified. These classes could be one of two fire regimes (2 or 4) dependent on what particular species are present. These classes were labeled as fire regime 2 or 4.

7. Merged with Prineville and Burns Fire regime maps

The latest fire regime maps for Prineville and Burns were acquired. See Appendix IV

8. Overlay Forest Service Fire Regime Data.

To make the east side fire regime map as complete, up-to-date, and as accurate as possible any fire regime maps from the Forest Service (Fremont and Wallowa-Whitman Forests) were included. See Appendix IV

9. Area Statistics

The number of acres/hectares/square miles for BLM, Forest Service, private and other land for each fire regime was calculated. See Appendix V for method and see below for the results.

Fire Regime	BLM			FOREST SERVICE		
	Acres	Hectares	Sq. Miles	Acres	Hectares	Sq. Miles
I	237,316	96,038	371	2,991,039	1,210,430	4,673
II	3,679,699	1,489,120	5,750	1,452,875	587,957	2,270
III	164,937	66,748	258	2,060,858	833,999	3,220
IV	867,150	350,923	1,355	989,462	400,421	1,546
IVa	1,594,880	645,424	2,492	2	1	0
IVb	778,374	314,996	1,216	46	19	0
IVc	252,213	102,067	394	4	2	0
II or IV	5,292,668	2,141,865	8,270	106,455	43,081	166
V	229,238	92,769	358	407,481	164,902	637

Fire Regime	PRIVATE			OTHER		
	Acres	Hectares	Sq. Miles	Acres	Hectares	Sq. Miles
I	1,628,458	659,013	2,544	268,028	108,467	419
II	6,589,531	2,666,687	10,296	699,498	283,077	1,093
III	883,920	357,709	1,381	145,107	58,723	227
IV	1,341,907	543,050	2,097	88,737	35,911	139
IVa	336,755	136,280	526	42,013	17,002	66
IVb	172,139	69,662	269	27,261	11,032	43
IVc	44,330	17,940	69	1,741	705	3
II or IV	1,809,985	732,474	2,828	620,468	251,094	969
V	90,284	36,536	141	6,928	2,804	11

EASTERN OREGON-EASTERN WASHINGTON VEGETATION MAP

Appendix I – Bob Rietman's Documentation

PURPOSE

This map was prepared to provide data to aid fuels condition class modeling for the portion of Oregon and Washington that did not have consistent vegetation mapping in place. It is intended to be an interim map product to enable modeling for fuels condition class in areas lacking other more suitable vegetation data. Some 70 million acres were mapped in 9 months by one person – this is not the end-all vegetation map for this area!

METHOD

This mapping was created by doing unsupervised classifications of 1999 and 2000 Landsat images of eastern Washington and eastern Oregon. All work was done in Clark 1866, NAD 27, UTM zone 11. Classification was done using Erdas "Imagine" software.
Landsat images were subdivided into smaller data sets or "tiles" to facilitate data handling and to reduce somewhat the variability within each file. Initial classification was done to 30 classes using bands 3,4,5,7. Classes were identified as best as possible in the office, then strip maps were printed for a sample of each tile and the data was corrected "on the ground". This information was then used to make adjustments in the labels for the classes as appropriate. In several cases classes were "confused" as to what they represented, one vegetation type in one area and something different in another area. In this situation the classes involved were lifted out, re-classified by the software and re-identified, then overlaid over the original. This resulted in files with more than 30 classes, but several of the classes are labeled "null".

It is expected that these files will be re-assembled using GIS techniques making a seamless file and "smoothing" some of the differences where tiles join. This will then be converted from grid files to polygon files which will greatly simplify the data for further analysis.

EVALUATION

Due to time and cost constraints, this mapping has not been evaluated for error through any formal process. I would estimate that about 70% to 80% of the pixels are correctly classified, most of the remaining will be in an "adjacent" class either in species or in density, with something like 5% or so classed wrongly. Many of these incorrect classifications are features like roads and parking lots, (often classed as "grass"), and very wet vegetation as in marshes that frequently classed as "mixed conifer" or "ponderosa pine", or as "ag/riparian". These can often be corrected by overlaying appropriate data from other sources in GIS.

Very large areas of eastern Washington and some of eastern Oregon are in dryland farming for grain crops. Some effort was made to identify differences in grain, dry grass, dry agriculture, as areas that had been recently or were currently cultivated, as opposed to "grass" or "sage1/grass" as areas that haven't been cultivated, or haven't been for some time. The cultivated areas frequently change annually so care must be taken to model them accordingly.

Similarly, those areas under irrigation change rapidly, in some cases one can see the effects of center-pivots in the moisture gradient around the fields. Wet meadows were not normally distinguishable from irrigated agriculture in many cases, so these were classed together. They should be fairly easy to separate in modeling based on locations.

Rock outcrops and shadows were difficult to class correctly, generally I tried to class them with the most typical vegetation on these sites in the given area.

Urban areas classed very poorly, They show as a mix of many types and will need to be overlain with other data in GIS.

CLASSIFICATION SCHEME

Attached below is the classification scheme used for this project. Timber type species codes are:

PP	ponderosa pine
MC	mixed conifer (Douglas fir, true firs, mixed species)
JUN	juniper
SA	sub-alpine fir and associated species
LP	lodgepole pine
Deciduous	used when fairly certain, often mixed with riparian or lost in urban areas.

Brush species codes are:

Sage	sagebrush and associated species
Grease	greasewood, when separable from sage
BB	bitterbrush
RB	rabbit brush, when separable from sage

The density classes are approximate. Without many plots to set density classes these are best considered as “relative density groups”. Users will need to use the data in the field some to gain familiarity with the classes as mapped.

I.

II. CURRENT VEGETATION CLASSIFICATION

LABEL	SPECS	CODE
NON-VEG	<10% VEG COVER	
-WATER	RIVERS, LAKES, PONDS	WATER
-BARREN-DARK	USUALLY BASALT	ROCK
-BARREN-LIGHT	ALKALI OR BARE SOIL	BARREN
VEGETATED	>10% VEG COVER	
-WET		
-RIPARIAN	NON IRRIGATED WET AREAS	RIPARIAN
-AGRICULTURE	IRRIGATED WET AREAS	AGRICULTU
-DRY		
GRASS	BRUSH OR TREES <10%	GRASS
BRUSH	BRUSH >10% , TREES <10%	
-SPECIES GROUP		SAGE, JUN

-MEDIUM	>10% CANOPY COVER <25%	1	
-MED-HI	>25% CANOPY COVER <35%	2	
-DENSE	>35% CANOPY COVER		3
FOREST	TREES >10%		
-SPECIES GROUP			PP, DF, ETC
-LO DENSITY	>10% CANOPY COVER<40%	1	
-MED DENSITY	>40% CANOPY COVER,70%	2	
-DENSE	>70% CANOPY COVER		3

(NOTE: Juniper uses brush density classes)

Bob Rietman, Sept. 26, 2001

Appendix II – Fire Regime Descriptions

Fire Regimes of Oregon and Washington

I. 0-35 years, Low severity.

Typical climax plant communities include ponderosa pine, eastside/dry Douglas-fir, pine-oak woodlands, Jeffery pine on serpentine soils, oak woodlands, and very dry white fir. Large stand-replacing fire can occur under certain weather conditions, but are rare events (i.e. every 200+ years).

II. 0-35 years, Mixed and High severity

Includes true grasslands (Columbia basin, Palouse, etc.) and savannahs with typical return intervals of less than 10 years; mesic sagebrush communities with typical return intervals of 25-35 years and occasionally up to 50 years, and mountain shrub communities (bitterbrush, snowberry, ninebark, ceanothus, Oregon chaparral, etc.) with typical return intervals of 10-25 years. Certain specific communities include mountain big sagebrush and low sagebrush-fescue communities. Grasslands and mountain shrub communities are not completely killed, but usually only top-killed and resprout.

III.35-100+ years, Mixed severity

This regime usually results in heterogeneous landscapes. Large, high severity fires may occur but are usually rare events. Such high severity fires may “reset” large areas (10,000-100,000 acres) but subsequent mixed severity fires are important for creating the landscape heterogeneity. Within these landscapes a mix of stand ages and size classes are important characteristics; generally the landscape is not dominated by one or two age classes. In southeastern Oregon this regime also includes aspen, riparian communities, most meadows, and wetlands.

A. <50 years, Mixed severity

Typical potential plant communities include mixed conifer, very dry westside Douglas-fir, and dry grand fir. Lower severity fire tends to predominate in many events.

B. 50-100 years, Mixed severity

Typical climax plant communities include well drained western hemlock; warm, mesic grand fir, particularly east of the Cascade crest; and eastside western redcedar. The relative amounts of lower and higher severity patches within a given event is intermediate between IIIa and IIIc.

C. 100-200 years, Mixed severity

Typical potential plant communities include western hemlock, Pacific silver fir, and whitebark pine at or below 45 degrees latitude and cool, mesic grand fir and Douglas-fir. Higher severity fire tends to dominate in many events.

IV. 35-100+ years, High severity

Seral forest communities that arise from or are maintained by high severity fires, such as lodgepole pine, aspen, western larch, and western white pine, often are important components in this fire regime. Dry sagebrush and mountain-mahogany communities also fall within this fire regime. Natural ignitions within this regime that result in large fires may be relatively rare, particularly in the Cascades north of 45 degrees latitude.

A. 35-100+ years, High severity, Juxtaposed

Typified by what would normally be considered long interval regime that lies immediately above a shorter interval or lower severity fire regime. Most often the fire originates lower on the slope and burns uphill into regime IVa. In southeastern Oregon, this subregime includes Wyoming big sagebrush communities on deeper soils below 5000 feet elevation. Forest examples include lodgepole pine immediately above ponderosa pine in the eastside Washington Cascades and aspen imbedded within dry grand fir in the Blue Mountains. This regime is often found in lower elevations or drier sites than is considered typical for regime IV.

B. 100+ years, High severity, Patchy arrangement

Typical potential forest communities include subalpine fir and mountain hemlock parkland and whitebark pine north of 45 degrees latitude.

Other community types include mixed Wyoming big sagebrush and low sagebrush on low productivity sites such as scablands, stiff sagebrush, and true old growth juniper savannah (<10% canopy closure). Some forbs are present, such as Sandberg's bluegrass and the availability of many of these areas for burning depends on wet years that result in much greater grass production than is typical. Typical fire return intervals in these communities is 100-150 years.

C. 100-200 years, High severity

Typical forest plant communities include subalpine mixed conifer (spruce-fir), western larch, and western white pine. Important potential forest plant communities include mountain hemlock in the Cascades and Pacific silver fir north of 45 degrees latitude.

Other plant communities include the intergrade between Wyoming big sagebrush and greasewood, shadescale on non-alkali soils, spiny hopsage, and alpine grasslands and heath in southeastern Oregon.

V. >200 years, High severity

This fire regime occurs at the environmental extremes where natural ignitions are very rare or virtually non-existent or environmental conditions rarely result in large fires. Sites tend to be very cold, very hot, very wet, very dry or some combination of these conditions.
Typical plant communities include black sagebrush, salt desert scrub, greasewood on dunes, true old-growth juniper with at least 10% canopy closure and mountain-mahogany in rocky areas, and alpine communities and subalpine heath in the Blue Mountains and Cascades. Most species tend to be small and low growing. Bare ground is common.

A. 200-400 years, High severity

Forest plant communities are at least somewhat fire adapted. Typical plant communities include Douglas-fir, noble fir, and mountain hemlock on drier sites in parts of western Washington.

B. 400+ years, High severity

Forest plant communities are weakly fire adapted or not fire adapted. Typical plant communities include Douglas-fir, Pacific silver fir, western hemlock, western redcedar, and mountain hemlock on moister sites in western Washington.

C. No Fire

This regime includes forest plant communities with no evidence of fire for 500 years or more. Stands often have extremely deep duff layers on poorly developed soils. Typical plant communities include Sitka spruce and Pacific silver fir along the Oregon and Washington coast and very wet western redcedar sites.

Appendix III – Fire Regime Classification of Veg Cover

Value	Class Names	vale fire regime	prineville
255	background		
1	water		
2	urban		
3	agriculture		
4	barren		
5	snow		
6	topo shadow		
7	riparian	3	4
8	lava		
9	null		
10	deciduous forest	4	4
11	forbs	2	
12	grass	2	2
13	greaswood low	4	
14	greasewood medium	4	
15	greasewood, sagebrush	4	
16	juniper low	4	
17	juniper medium	4	
18	juniper, grass	4	2
19	juniper, sagebrush	4	
20	lodgepole pine medium	3	3
21	lodgepole pine high	3	3
22	lodgepole pine, bitterbrush	3	3
23	lodgepole pine, Englemann spruce	3	3
24	mixed conifer medium	3	
25	mixed conifer high	3	
26	mixed conifer, shrub	3	
27	mountain mahogany	4	
28	ponderosa pine low	1	1
29	ponderosa pine medium	1	1
30	ponderosa pine high	1	1
31	ponderosa pine, bitterbrush	2	
32	ponderosa pine, Douglas fir	3	
33	ponderosa pine, grass	1	
34	ponderosa pine, lodgepole pine	3	
35	rabbitbrush	2	
36	rabbitbrush, grass	2	
37	rabbitbrush, bitterbrush, sagebr	2or4	
38	rabbitbrush, bitterbrush, grass	2or4	
39	sagebrush low	2or4	2 or 4
40	sagebrush medium	2or4	2 or 4
41	sagebrush high	2or4	2 or 4
42	sagebrush, grass	2or4	2 or 4
43	sagebrush, greasewood	4	
44	shrub	2or4	2 or 4
45	shrub, forb	2or4	

46	shrub, grass	2or4
47	spiny hopsage	4
48	subalpine fir high	

Appendix IV - Merging Fire Regimes

The Fire Regime maps for Vale, Lakeview, Burns, Prineville, Fremont and Wallowa Whitman were merged to create a mosaic. Each fire regime map needed to be standardized to one format (ESRI Grid) prior to merging. Each Fire Regime map was obtained in a different format (polygon or raster) with different attributes and ancillary information. The following processes were used to create and maintain consistency between the maps in order to merge them into a continuous ESRI Grid.

1. Each fire regime map was converted to a polygon coverage with standard items, characters, and attributes. For example, the item “FIRE_REGIME” was added to each map and standardized by using Roman numerals to describe the attribute.

2. A list of all possible combinations of attributes that were of interest was created for each fire regime map using the ArcPlot INFOFILE command. This list of all the possible values was simplified using the FREQUENCY command by creating a summary of all possible combinations.

3. The FREQUENCY command outputs a text file was named “allval_freq” that has an item labeled “CASE# “. It is this “CASE#” that is used to create grids from the subsets.

4. The attribute “CASE#” was joined to each fire regime polygon map. To do this, each polygon map and the “allval_freq” info files were REDEFINED in ArcInfo. REDEFINE is used to specify multiple names, item types, and item widths for previously defined items in a data file.

The items COVER_TYPE and FIRE_REGIME were redefined to create an item called COVER-FIRE. The COVER-FIRE item was then used as the relate item to join the polygon maps to the frequency file using the JOINITEM command in Arc. The output info files contained the item CASE# which provides a unique value to each possible combination of items in all subsets.

5. There now exists a unique item to allow the polygon maps to be converted into grids. This was achieved using the Arc command POLYGRID or the Spatial Analyst extension in ArcMap.

6. The output grid has no attributes except the item VALUE that mirrors the CASE# item. To add the correct attribute information to the grid the “allval_freq” info file must be joined to the grids. To do this VALUE must be added to the “allval_freq” file using the Arc command ADDITEM. Then the attributes of CASE# need to be placed in the new VALUE column by editing each subset’s attribute table in ArcMap-ArcInfo by calculating the values for the VALUE column (VALUE = CASE#). The “allval_freq” file can now be joined to each grid subset using VALUE as the relate item.

7. Once all grids are standardized for each fire regime map they were merged in ArcGrid using the MERGE command. The grids were merged in this order using this sequence of command:
Output = merge(Fremont, Wallowa Whitman, Prineville, Burns, Vale, Lakeview)

The order of input determines the priority of the grid, with the last grid having the lowest priority. The SETNULL command was used to negate pixels of no value before the grids were merged to allow grids that have values, but have lower priority to gain priority over grids with no data.

Appendix V – Area Statistics

To compute area statistics by ownership it was necessary to add ownership to the fire regimes grid. An ownership layer of the study area was obtained and simplified into four ownership categories: BLM, Forest Service, Private and Other.

This ownership layer was then turned into a Grid. The COMBINE command was used to combine the ownership and fire regimes grids (output = combine(east_fire, ownership)). The item EAST_FIRE was then added to the master info file (allval_freq) and used as the relate item to join the file to the output grid. Once joined unnecessary items were dropped. The output grid included items: COVER_TYPE, FIRE_REGIME and OWNERSHIP.

Area columns including: acres, hectares and square miles were added in ERDAS Imagine. These columns can then be extracted and used to generate a report for area statistics.